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by Margot Shields and Kathryn Wilkins

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..	not available for a specific reference period
...	not applicable
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0^s	value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{p}	preliminary
^{r}	revised
x	suppressed to meet the confidentiality requirements of the *Statistics Act*
^{E}	use with caution
F	too unreliable to be published
*	significantly different from reference category ($p < 0.05$)

Smoking, smoking cessation and heart disease risk: A 16-year follow-up study

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Abstract

Background

Smoking is a major risk factor for heart disease. Over the past decade, the prevalence of smoking and the number of cigarettes smoked per day have decreased in Canada. Using a contemporary cohort of Canadian men and women, this study measured associations between smoking, smoking cessation and heart disease.

Methods

The study is based on nine cycles of data (1994/1995 through 2010/2011) from the National Population Health Survey, which collected information on smoking status every two years. The study sample consists of 4,712 men and 5,715 women aged 25 or older and free from heart disease in 1994/1995. Heart disease was determined by self-report of diagnosis, medication for, or death from heart disease. Relative risks of incident heart disease were compared among current daily smokers, former daily smokers, and those who never smoked daily.

Results

Compared with those who had never smoked daily, current daily smokers had a 60% higher risk of incident heart disease during the follow-up period. The risks were lower among current daily smokers who consumed fewer cigarettes. Although smoking cessation was associated with a lower risk of heart disease, 20 or more years of continuous cessation were required for the risk to approach that of people who never smoked daily.

Interpretation

Smoking cessation and cutting down the number of cigarettes smoked per day reduce the risk of heart disease.

Keywords

Cohort study, longitudinal studies, relative risks

Authors

Margot Shields and Kathryn Wilkins were formerly with the Health Analysis Division at Statistics Canada.

Heart disease is the second-leading cause of death in Canada, accounting for just over 20% of all deaths in 2009.[1] Thirty years ago, the U.S. Surgeon General's Report on *The Health Consequences of Smoking: Cardiovascular Disease* concluded that smoking is causally related to coronary heart disease for both men and women.[2]

It is also well established that smoking cessation reduces the risk of heart disease.[3] Less certain is how many years of cessation are needed for former smokers' risk to decline to the level of people who never smoked. According to the 1990 Surgeon General's Report, *The Health Benefits of Smoking Cessation*, 15 years of abstinence are required.[3] However, this conclusion was largely based on results for male cohorts that were reported in studies conducted before the 1980s. Many of these studies did not consider the amount smoked—"smoking intensity"—an important determinant of heart disease risk for both current and former smokers.[3]

In Canada, the proliferation of public smoking bans that began in the late 1990s coincided with increased percentages of smokers reporting restrictions at home, higher rates of smoking cessation, and reduced consumption among those who continued to smoke.[4]

Using observations of a contemporary cohort of Canadian men and women, this study measures the association between daily smoking and the risk of heart disease. As well, the number of years of cessation required for former daily smokers to achieve a risk level similar to that of people who have never smoked daily is quantified. The study is based on data collected from 1994/1995 through 2010/2011 by the National Population Health Survey (NPHS).

Methods

Data source

The analysis is based on longitudinal data from nine NPHS cycles (1994/1995 through 2010/2011). The target population of the NPHS Household component is the household population of the 10 Canadian provinces in 1994/1995, excluding residents of Indian Reserves, health care institutions, Canadian Forces Bases and some remote areas.

In 1994/1995, 20,095 households were selected for the NPHS longitudinal panel. One person in each household

was chosen at random, 86% of whom (17,276) completed the General component of the questionnaire in 1994/1995. Since then, attempts have been made to interview these persons every two years. Detailed descriptions of the NPHS design, sample and interview procedures are available elsewhere.[5,6]

This study is based on information from respondents who were aged 25 or older in 1994/1995.

Measures

Heart disease

Incident cases of heart disease were identified by self-reported diagnosis of heart disease, use of heart medication, or death from heart disease. The presence of chronic conditions was determined by self-report of diagnosed illness. NPHS respondents were asked about any "long-term health conditions that have lasted or are expected to last six months or more and that have been diagnosed by a health professional"; heart disease was included in a check-list of conditions. Use of heart medication was determined by asking respondents if, in the past month, they had taken "medicine for the heart." Heart disease death was based on death certificate information indicating ICD-10 codes I11, I13, or I20-I51 as the underlying cause of death.

When incident heart disease was reported by a respondent (in cycle i) after a cycle in which no response was reported (cycle i-1), it was assumed that the case occurred midway between cycle i-1 and cycle i. Records in which heart disease was reported after two cycles of non-response were excluded (n=61).

Smoking status

Smoking status was based on responses to the following questions:

1. At the present time do you smoke cigarettes daily, occasionally or not at all?
2. Have you ever smoked cigarettes daily?

Current daily smokers were those who answered "daily" to question 1; *former daily smokers* were those who answered "occasionally" or "not at all" to question 1 and "yes" to question 2. Never daily smokers were those who responded "occasionally" or "not at all" to question 1 and "no" to question 2. Former daily smokers were asked, "At what age did you stop smoking cigarettes daily?" This was used in conjunction with age at interview to calculate the number of years since quitting daily smoking.

Based on this information, for every NPHS cycle, each respondent was categorized as a "current daily smoker"; a "former daily smoker" who had quit for 4 or fewer years, 5 to 9 years, 10 to 14 years, 15 to 19 years, or 20 or more years; or "never a daily smoker." In each cycle, current and former daily smokers were asked the number of cigarettes usually smoked per day. This was used as a measure of smoking intensity.

When information on smoking status was missing in a given cycle but was available in previous and subsequent cycles, this information was used to impute smoking status for the missing cycle. Smoking status was imputed for at least one cycle for 20% of the respondents in this study (12% for one cycle, 5% for two cycles, and 3% for three or more cycles).

The number of two-year changes in smoking status was derived, defined as a change in smoking status between consecutive cycles. For example, if a respondent reported being a former daily smoker in cycle 1, a current daily smoker in cycle 2, a former daily smoker in cycle 3, and a current daily smoker in cycles 4 to 9, the number of changes would be set to three.

Covariates

Variables representing factors known to be potential confounders of the association between smoking status and incident heart disease were included in multivariate models: age (used as a continuous variable), diabetes, hypertension, low household income (lowest 20th percentile of the percentage distribution), low level of education (less than secondary school graduation), marital status (married or living with a partner), obesity (body mass index 30 kg/m^2 or higher), physically inactive in leisure-time, having a regular medical doctor, daily alcohol consumption, and among women, use of hormone replacement therapy or oral contraceptives.

Analysis

Descriptive statistics were used to provide characteristics of the study population in 1994/1995. One-year relative risk ratios of incident heart disease by person-years at risk were examined in relation to smoking status using multivariate models controlling for potential confounders. Relative risks were based on conditional risk marginals computed using SUDAAN software.[7]

A "person-years-at-risk follow-up file" was created. Of the 12,455 NPHS respondents aged 25 or older at baseline (1994/1995), 980 reported heart disease or use of medication for heart disease in 1994/1995 and were excluded from the analysis. Of the remaining 11,475 respondents, 1,048 (9%) were excluded because of missing or inconsistent information:

- 411 indicated heart disease in only one cycle and subsequently reported they did not have heart disease. (If heart disease was reported in two or more cycles, this was accepted as an incident case.)
- 61 were missing information on heart disease in cycle(s) before it was reported (that is, the time of incidence could not be determined).
- 120 had missing values for smoking status across all cycles.
- 456 had information on smoking status only at cycle 1 (missing for all subsequent cycles), and information on heart disease was missing at cycle 2.

The remaining 10,427 respondents contributed at least one observation to the person-years-at-risk follow-up file. Records were written to this file for each consecutive pair of cycles (cycle i and cycle i+1) as follows:

- If heart disease or medication for heart disease was *not* reported at cycle i+1, two records were written

to the file with heart disease set to "no."

- If heart disease or medication for heart disease was reported at cycle i+1, it was assumed that incident heart disease occurred halfway through the two-year follow-up period. One record was written to the file with heart disease set to "no," and one record with heart disease set to "yes." No further records were written to the file for these respondents.
- If death from heart disease was reported at cycle i+1, the time between the date of death and the date of the cycle i interview was derived.
  - If less than one year had elapsed, only one record was written to the file with heart disease set to "yes."
  - If more than one but less than two years had elapsed, two records were written to the file, with heart disease set to "no" in the first, and to "yes" in the second.
  - If two years had elapsed (this occurred when the date of death followed the date that the interview at cycle i+1 was to have taken place), three records were written to the file, with heart disease set to "no" in two, and to "yes" in the third.

For each record, values of the smoking and covariate variables were those reported at cycle i. For example, if a respondent was free from heart disease in 1994/1995 (cycle 1), reported heart disease for the first time in 2004/2005 (cycle 6) and reported being a current daily smoker in 1994/1995, a former daily smoker in 1996/1997, 1998/1999 and 2000/2001, and a current daily smoker in 2002/2003, 10 records would be written to the person-years-at-risk follow-up file for this respondent. Two records would have heart disease set to "no" and smoking status set to "current daily" to reflect the situation in 1994/1995; six records would have heart disease set to "no" and smoking status set to "former daily smoker" to reflect the situation in 1996/1997, 1998/1999 and 2000/2001 (with appropriate updates to the number of years since quitting); and one record would have heart disease set to "no" and smoking status set to "current daily," and a second record would have heart disease set to "yes" and smoking status set to "current daily," to reflect the situation in 2002/2003.

When values for smoking status at cycle i or heart disease at cycle i or cycle i+1 were missing, no records were written.

Respondents who moved into institutions were followed up and included in this study.

Appendix Table A displays the number of records written to the person-years-at-risk follow-up file for each consecutive pair of cycles, the number of records with an incident case of heart disease, and the number of follow-up years excluded from the analysis because of missing values for smoking status and/or heart disease.

Previous research has shown that the risk of heart disease in relation to smoking status differs between men and women[8]; therefore, models were run separately by sex.

In one set of models, people who never smoked daily were used as the reference group to quantify the elevated risks of heart disease for current and former smokers. In a second set of models, an approach recommended in the 1990 Surgeon General's Report on *The Health Benefits of Smoking Cessation* was used in order to estimate the number of years of cessation required for former smokers to achieve a risk level similar to that of people who had never smoked.[3] Current smokers were used as the reference group. This method makes it possible to determine if the benefits of quitting persist when controlling for smoking intensity and age of initiation. Research has found that former smokers tend to have smoked fewer cigarettes per day and to have initiated at older ages.[3] Therefore, failure to control for intensity and age of initiation may exaggerate the benefits of cessation.[3]

All estimates are based on weighted data. Variance estimates were calculated using the bootstrap technique to account for the complex survey design of the NPHS.[9]

Results

Men more likely to be smokers

The study sample consisted of 4,712 men and 5,715 women aged 25 or older and free of heart disease in 1994/1995 (Table 1). During the 16-year follow-up, 18% of men and 14% of women were either diagnosed with or died from heart disease.

At baseline (1994/1995) men were more likely than women to be current daily smokers (31% versus 25%) or former daily smokers (39% versus 28%). Among former smokers, about one-quarter of both men and women reported that they had quit 20 or more years earlier.

Transitions common

Transitions in smoking status over the 16-year follow-up were fairly common, particularly among current smokers and short-term quitters. Of those who were current daily smokers at baseline, more than half reported at least one subsequent change in status; that is, they reported quitting during follow-up. Of those who were short-term quitters (four or fewer years) at baseline, approximately one-third reported a relapse during follow-up. Very few who reported at baseline that they had never smoked daily reported a change in status, indicating that smoking initiation is rare beyond age 25.

Higher intensity among men

At baseline, men who were current or former daily smokers reported higher smoking intensity levels than did women.

Men who had quit for 15 or more years reported lower intensity levels than did current male smokers. Female former smokers reported lower intensity levels than did current smokers, regardless of the number of years since quitting; intensity levels were particularly low among

Table 1
Descriptive statistics of weighted sample, by sex, household population aged 25 or older without heart disease in 1994/1995

	Men (n=4,712)	Women (n=5,715)
Mean age (1994/1995)	44.9	46.4*
Incident heart disease during follow-up[†] (%)	18.1	13.6*
Died from heart disease during follow-up (%)	2.8	2.1
Smoking status distribution (1994/1995) (%)		
Current daily smoker	30.9	24.8*
Former daily smoker	38.5	28.1*
Never smoked daily	30.6	47.1*
Distribution of years since quitting daily smoking (among former daily smokers in 1994/1995) (%)		
4 or fewer	20.4	22.0
5 to 9	19.8	22.4
10 to 14	19.2	16.8
15 to 19	15.3	13.9
20 or more	25.3	24.9
Distribution of number of two-year changes in smoking status (1996/1997 to 2010/2011) (%)		
0	77.4	82.9*
1	12.1	9.2*
2	6.3	4.4*
3 or more	4.3	3.5
At least one two-year change in smoking status (1996/1997 to 2010/2011), by smoking status in 1994/1995 (%)		
Total	22.6	17.1*
Current daily smoker	55.6	53.6
Former daily smoker		
Years since quitting daily smoking		
4 or fewer	32.2	34.9
5 to 9	14.7[E]	11.9[E]
10 to 14	7.1[E]	5.3[E]
15 to 19	F	6.1[E]
20 or more	F	F
Never smoked daily	2.5[E]	0.9*[E]
Average number of cigarettes smoked per day, by smoking status in 1994/1995		
Current daily smoker	20.6	17.3*
Former daily smoker	19.5	14.0*[‡]
Years since quitting daily smoking		
4 or fewer	20.6	15.5*[‡]
5 to 9	20.5	15.2*[‡]
10 to 14	20.6	14.8*[‡]
15 to 19	17.9[‡]	14.6*[‡]
20 or more	18.2[‡]	10.8*[‡]
Average age started daily smoking, by smoking status in 1994/1995		
Current daily smoker	16.8	17.7*
Former daily smoker	17.2	18.8*[‡]
Years since quitting daily smoking		
4 or fewer	17.6	18.7
5 to 9	17.6	18.3
10 to 14	16.9	18.3*
15 to 19	16.4	17.9*
20 or more	17.2	20.3*[‡]

[†] self-reported heart disease, medication for heart disease, or death from heart disease
* significantly different from men ($p<0.05$)
[‡] significantly different from current daily smoker ($p<0.05$)
[E] use with caution
F too unreliable to be published
Source: 1994/95 to 2010/11 National Population Health Survey, longitudinal sample

women who had quit for 20 or more years.

Age of initiation

Among current daily smokers, the average age of initiation (daily smoking) was one year younger for men than women (17 versus 18). Men who were current and former daily smokers had similar initiation ages. Women who had quit for 20 or more years had an older age of initiation than did current daily smokers.

Fewer smokers, lower intensity

Table 2 provides estimates of smoking status based on the person-years-at-risk follow-up file for each two-year period (that is, for those without heart disease at the beginning of each two-year period). Among both sexes, the percentage of current daily smokers dropped sharply over time, and the percentage of quitters (former daily smokers among those who ever smoked daily) rose from just over half in 1994/1995 to almost three-quarters in 2008/2009. As well, intensity levels declined among current daily smokers of both sexes, and among male former daily smokers. These reductions may, in part, reflect higher survival rates among quitters and smokers with lower intensity levels, since the estimates pertain to individuals who were still alive and without heart disease. Nonetheless, data based on cross-sectional samples from 1994/1995 and 2009 (Appendix Table B) reveal similar trends in the general population for men and women in all age groups.

Higher risk of heart disease

During the 16-year follow-up, current daily smokers were 60% more likely to have been diagnosed with, or to have died from, heart disease than were people who had never smoked daily (Table 3). Higher intensity was associated with greater risk. Men who smoked 25 or more cigarettes a day had twice the risk of heart disease, compared with those who had never smoked daily. Women who smoked 15 or more cigarettes a day had higher risks, and even those who smoked fewer than 15 cigarettes a day had an

Table 2
Smoking status and intensity, by sex and survey year, household population aged 25 or older without heart disease in 1994/1995

Sex/Survey year	Smoking status (%)				Cigarettes per day (mean)	
		Former daily smoker				
	Current daily smoker	% based on total	% based on those who ever smoked daily	Never smoked daily	Current daily smoker	Former daily smoker
Men						
1994/1995	30.9*	38.4*	55.4*	30.6*	20.6*	19.5*
1996/1997	29.9*	39.4*	56.8*	30.7*	19.6*	19.3*
1998/1999	28.1*	40.9*	59.3*	31.0*	19.0	18.7*
2000/2001†	25.1	43.1	63.2	31.8	18.7	18.0
2002/2003	21.5*	46.3*	68.3*	32.2	17.6*	17.9
2004/2005	20.6*	46.7*	69.4*	32.7*	17.5*	17.6
2006/2007	18.5*	47.9*	72.1*	33.5*	17.5*	17.3*
2008/2009	18.0*	48.2*	72.8*	33.8*	17.3*	16.9*
Women						
1994/1995	24.8*	28.1*	53.2*	47.1	17.3*	14.0
1996/1997	23.6*	29.2*	55.3*	47.2	16.4*	14.1
1998/1999	22.5*	30.6*	57.6*	46.9	16.0*	14.6*
2000/2001†	20.0	33.0	62.3	47.0	15.5	14.3
2002/2003	17.7*	34.8*	66.2*	47.4	15.0	13.9
2004/2005	16.9*	35.4*	67.6*	47.7	15.2	13.8
2006/2007	16.0*	35.9*	69.2*	48.1*	14.6*	13.8
2008/2009	14.2*	37.4*	72.4*	48.4*	14.8	13.7

† reference year
* significantly different from reference year
Note: Estimates are based on population without heart disease at each survey year.
Source: 1994/1995 to 2010/2011 National Population Health Survey, longitudinal sample (person-years-at-risk follow-up file).

increased risk (50%) when other factors related to heart disease were included in the model. Compared with people who never smoked daily, the relative risk of incident heart disease for former daily smokers was 1.2 for men and 1.3 for women.

At least 20 years

Table 4 provides estimates of the relative risks of heart disease using current daily smokers as the reference group. This makes it possible to see if the benefits of quitting persist when controlling for smoking intensity and age of initiation.

Compared with current daily smokers, the relative risk of incident heart disease among those who had never smoked daily was 0.6 for both men and women. Among male former daily smokers, the relative risk of heart disease declined with the number of years since quitting, but only after 20 years of continuous cessation did the relative risk (0.7) fall significantly below that for current daily smokers and approach that for those who had never smoked daily. Similarly, among female former daily smokers, only after 20 years of continuous cessation was the relative risk (0.7) significantly lower than that for current daily smokers. However, when controlling for intensity, the reduced risk for women who had quit for 20 or more years no longer attained statistical significance (p=0.06).

When risk was examined in models using never daily smokers as the reference group, the relative risk of incident heart disease for people who had quit for 20 or more years was 1.1, which was not significantly different (data not shown).

Discussion

This study, based on observations of a contemporary cohort of the Canadian population aged 25 or older, quantifies the increased risk of heart disease associated with daily cigarette smoking and the benefits of cessation.

Strengths of the study include a large representative sample, a 16-year follow-up, and information on smoking status and smoking intensity that was updated every two years. Because quitting and relapsing were common over the 16 years, frequent revision of smoking status was essential to avoid misclas-

What is already known on this subject?

- Heart disease is the second-leading cause of death in Canada, accounting for just over 20% of all deaths in 2009.
- Smoking is causally related to coronary heart disease for both men and women.
- Over the past decade, the prevalence of smoking has declined in Canada, as have smoking intensity levels among current daily smokers.
- Smoking cessation reduces the risk of heart disease, but the number of years of cessation required for the risk for former smokers to decline to the level for those who never smoked is uncertain.

What does this study add?

- Based on a contemporary cohort of the Canadian population followed from 1994/1995 to 2010/2011, the risk of incident heart disease was 60% higher among current daily smokers than among people who never smoked daily.
- Although smoking cessation was associated with a decreased risk of incident heart disease, 20 continuous years of cessation were needed for the risk of heart disease for former daily smokers to approach that for people who never smoked daily.

Table 3
Adjusted relative risk ratios of heart disease, by sex and smoking status, household population aged 25 or older without heart disease in 1994/1995

	Men						Women					
	Model A (adjusted for age)			Model B (adjusted for age and other covariates†)			Model A (adjusted for age)			Model B (adjusted for age and other covariates†)		
	Relative risk ratio	95% confidence interval		Relative risk ratio	95% confidence interval		Relative risk ratio	95% confidence interval		Relative risk ratio	95% confidence interval	
		from	to		from	to		from	to		from	to
Smoking status												
Current daily smoker	1.6*	1.2	2.1	1.6*	1.2	2.2	1.6*	1.2	2.1	1.7*	1.3	2.2
Former daily smoker	1.2	1.0	1.5	1.1	0.9	1.5	1.3*	1.1	1.6	1.4*	1.1	1.7
Never smoked daily‡	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...
Current daily smoker												
Cigarettes per day												
14 or fewer	1.3	0.8	2.0	1.4	0.9	2.2	1.3	0.9	1.8	1.5*	1.0	2.1
15 to 24	1.4	0.9	2.1	1.4	0.9	2.2	2.0*	1.4	3.0	2.0*	1.3	3.1
25 or more	2.0*	1.3	3.0	2.0*	1.3	3.0	1.7*	1.0	2.8	1.6*	1.0	2.7
Former daily smoker	1.2	1.0	1.5	1.1	0.9	1.5	1.3*	1.1	1.6	1.4*	1.1	1.7
Never smoked daily‡	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...

† adjusted for age (continuous), diabetes, hypertension, low household income, education, marital status, obesity, leisure-time physical activity, having a regular medical doctor, daily consumption of alcohol, survey year and use of hormone replacement therapy or birth control pills by women
‡ reference group
* significantly different from reference group ($p<0.05$)
... not applicable
Source: 1994/1995 to 2010/2011 National Population Health Survey, longitudinal sample (person-years-at-risk follow-up file)

sification error and distortion of the associations between smoking status and heart disease.[3,10]

Relative risks for current daily smokers

The age-adjusted relative risk of incident heart disease observed in this study for current daily smokers versus people who never smoked daily (1.6 for both sexes) is, with few exceptions, lower than estimates from previous cohort studies.[3,10-33] Many studies have reported relative risks of 2 or more.[3,10,11,16,18,19,22,23,28,31-33]

The lower relative risk in this analysis likely reflects lower smoking intensity. At baseline in 1994/1995, cigarette consumption levels for the NPHS cohort were lower than those reported in most previous research, and decreased throughout the 16-year follow-up, mirroring a trend observed in the general Canadian population.

When findings of cohort studies initiated in the 1950s were compared with those of the 1970s and 1980s, relative risks were higher for smokers for all major smoking-related diseases.[34] For example, based on the Cancer Prevention Study I (CPS-I), initiated in the United States in 1959, the relative risk of death from coronary heart disease for current smokers was 1.7 for men and 1.4 for women, compared with never-smokers. In the Cancer Prevention Study II (CPS-II), initiated in 1982, the relative risks for current smokers were estimated at 1.9 for men and 1.8 for women. Much of the difference was attributed to changes in intensity levels[34,35]—between the baseline years of the CPS-I and CPS-II, the average number of cigarettes smoked per day rose from 22.4 to 25.4 among men, and from 15.3 to 19.6 among women. In the present NPHS study, men's average intensity at baseline (20.6 cigarettes per day) was lower than in the CPS-I study, and the relative risk of heart disease was also lower. Among women, average intensity at baseline (17.3) was between that observed in the two CPS studies, as was the relative risk of heart disease.

In cohort studies conducted during the 1950s and 1960s, the risks for current male smokers typically exceeded those for female smokers.[34,35] Differences between men's and women's smoking patterns at that time are presumed to explain men's higher risk. Smoking intensity and duration were substantially lower among women. It was not uncommon for women in these cohorts to have started smoking in their thirties or forties, unlike the majority of men who had started before age 21.

In subsequent decades, women's smoking patterns began to resemble those of men, putting women at a greater disadvantage. A systematic review of the literature for more recent cohorts concluded that relative risks were 25% higher among female than male current smokers, although the precise reasons for the higher disadvantage among women were unclear.[8] While similar relative risks were observed in the present study for male and female current smokers, the higher relative risks for females than

Table 4
Adjusted relative risk ratios of heart disease, by sex and smoking status, household population aged 25 or older without heart disease in 1994/1995

Sex/Smoking status	Model A (adjusted for age)			Model B (adjusted for age and other covariates[‡])			Model C[†] (adjusted for age, other covariates[‡] and smoking intensity)			Model D[†] (adjusted for age, other covariates,[‡] smoking intensity and age of smoking initiation)		
	Relative risk ratio	95% confidence interval		Relative risk ratio	95% confidence interval		Relative risk ratio	95% confidence interval		Relative risk ratio	95% confidence interval	
		from	to		from	to		from	to		from	to
Men												
Smoking status												
Current daily smoker[§]	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...
Years since quitting daily smoking												
4 or fewer	0.9	0.6	1.3	0.8	0.6	1.2	0.8	0.6	1.2	0.9	0.6	1.2
5 to 9	0.8	0.5	1.2	0.7	0.5	1.1	0.7	0.5	1.1	0.8	0.5	1.2
10 to 14	0.8	0.6	1.2	0.7	0.5	1.1	0.8	0.5	1.1	0.8	0.5	1.2
15 to 19	0.8	0.5	1.1	0.7*	0.5	1.0	0.7	0.5	1.0	0.7	0.5	1.0
20 or more	0.7*	0.6	0.9	0.7*	0.5	0.9	0.7*	0.6	1.0	0.7*	0.6	1.0
Never smoked daily	0.6*	0.5	0.8	0.6*	0.5	0.8	...	...	...	...	...	...
Age of smoking initiation												
14 or younger	...	...	...	...	...	...	...	...	...	1.3	1.0	1.7
15 to 17	...	...	...	...	...	...	...	...	...	1.3*	1.0	1.7
18 or older	...	...	...	...	...	...	...	...	...	1.0	...	...
Women												
Smoking status												
Current daily smoker[§]	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...
Years since quitting daily smoking												
4 or fewer	0.9	0.6	1.4	0.9	0.6	1.3	0.9	0.6	1.4	0.9	0.6	1.4
5 to 9	1.3	0.8	2.0	1.2	0.8	1.9	1.3	0.8	2.0	1.3	0.9	2.0
10 to 14	0.9	0.6	1.4	0.9	0.5	1.4	0.9	0.6	1.5	0.9	0.6	1.5
15 to 19	0.8	0.5	1.2	0.7	0.4	1.2	0.8	0.5	1.3	0.8	0.5	1.3
20 or more	0.7*	0.5	0.9	0.7*	0.5	0.9	0.7	0.5	1.0	0.7	0.5	1.0
Never smoked daily	0.6*	0.5	0.8	0.6*	0.4	0.8	...	...	...	...	...	...
Age of smoking initiation												
14 or younger	...	...	...	...	...	...	...	...	...	1.4	0.9	2.1
15 to 17	...	...	...	...	...	...	...	...	...	0.9	0.7	1.3
18 or older	...	...	...	...	...	...	...	...	...	1.0	...	...

† current and former daily smokers
‡ adjusted for age (continuous), diabetes, hypertension, low household income, education, marital status, obesity, leisure-time physical activity, having a regular medical doctor, daily consumption of alcohol, survey year, and among women, use of hormone replacement therapy or birth control pills
§ reference group
* significantly different from reference group ($p<0.05$)
... not applicable
Source: 1994/1995 to 2010/2011 National Population Health Survey, longitudinal sample (person-years-at-risk follow-up file)

males at lower intensity levels is consistent with the results of this review.

Benefits of smoking cessation

To study the benefits of smoking cessation, the relative risks of heart disease for former daily smokers and never daily smokers were compared with those for continuing daily smokers. Lower relative risks were observed as years of cessation increased, but only after 20 years did the relative risks of former daily smokers (0.7) approach those of people who never smoked daily (0.6). For women, when intensity and age of initiation were taken into account, although the relative risk for those who had quit for 20 years or longer remained at 0.7, it only approached statistical significance relative to current daily smokers.

Some research has found that the relative risks for former smokers return to the level of never-smokers within five years of cessation.[20,24,28,36] The results of the present study are more consistent with the conclusion of the 1990 U.S. Surgeon General's Report[3] that 15 years of abstinence are required, and with other studies that found that an even longer period is required.[12-14,37,38] The NPHS analysis benefitted from being able to control for smoking intensity, which tends to be lower in long-term quitters than in continuing smokers. Another longitudinal study based on the NPHS found that it

took 20 years for a broader measure of health—health-related quality of life—among former smokers to become similar to that of people who never smoked daily.[39]

Limitations

The main limitations of this study are self-reported data and the potential for non-response bias.

The degree to which self-reported diagnoses of chronic conditions, such as heart disease, are inaccurate because of reporting error is unknown. Smoking status, too, is based on self-report, although a validation study using urine cotinine as a biological marker of recent smoking indicates that self-reports provide accurate estimates of smoking status.[40] However, estimates of smoking intensity may be biased if heavy smokers are more likely to under-report consumption levels. As well, recall bias may have affected the accuracy of responses to number of years since quitting daily smoking.

Smoking status data were collected every two years, but no information was available on changes in smoking behaviour in the interval between survey interviews. For example, a respondent who reported being a former smoker in two consecutive cycles may have relapsed to become a daily smoker between interviews.

The impact of excluding NPHS respondents because of missing or inconsistent information (9%) is unknown. Among respondents retained in the study, biases may also result from non-response to heart disease or smoking status during the 16-year follow-up.

Finally, exposure to second-hand smoke might be expected to attenuate disease risk reduction for never daily and former daily smokers. However, people in these groups who were regularly exposed to second-hand smoke in the home had a reduction in heart disease risk statistically similar to that of those not exposed (data not shown).

Conclusion

Smoking cessation reduced the risk of heart disease, but the full benefits were realized only after 20 years of sustained cessation. Among individuals who continue to smoke, cutting down the number of cigarettes smoked also reduced risk. However, the lowest risk of heart disease was among people who never began smoking. ■

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Appendix

Table A
Sample sizes for person-years-at-risk included in study, incident cases of heart disease and person-years excluded because of non-response, by sex and National Population Health Survey (NPHS) cycle

	Men			Women		
NPHS cycle	Person-years-at-risk	Incident cases of heart disease	Person-years excluded because of non-response	Person-years-at-risk	Incident cases of heart disease	Person-years excluded because of non-response
Total	54,364	886	9,866	69,166	908	10,740
1994/1995 to 1996/1997	9,383	151	6	11,412	160	4
1996/1997 to 1998/1999	8,568	128	358	10,557	119	400
1998/1999 to 2000/2001	7,763	123	754	9,779	129	778
2000/2001 to 2002/2003	6,997	102	1,148	8,928	112	1,208
2002/2003 to 2004/2005	6,413	94	1,394	8,220	109	1,548
2004/2005 to 2006/2007	5,819	85	1,646	7,596	96	1,802
2006/2007 to 2008/2009	5,136	117	2,016	6,813	114	2,202
2008/2009 to 2010/2011	4,285	86	2,544	5,861	69	2,798

Source: 1994/1995 to 2010/2011 National Population Health Survey, longitudinal sample (person-years-at-risk follow-up file).

Table B
Percentage distribution of smoking status and smoking intensity, by sex, age group and survey year, household population aged 25 or older 1994/1995 and 2009

Sex/ Age group/ Survey year	Smoking status (%)				Cigarettes per day (mean)	
		Former daily smoker				
	Current daily smoker	% based on total	% based on those who ever smoked daily	Never smoked daily	Current daily smoker	Former daily smoker
Men						
Total 25 or older						
1994/1995	28.6	33.8	54.2	37.6	21.2	21.6
2009	18.6*	34.4	64.9*	46.9*	16.8*	19.0*
25 to 44						
1994/1995	33.3	22.4	40.2	44.3	20.7	18.7
2009	20.2*	22.3	52.5*	57.5*	15.3*	14.5*
45 to 64						
1994/1995	27.5	41.0	59.9	31.4	22.8	23.4
2009	21.1*	37.9	64.3*	41.0*	18.2*	20.0*
65 or older						
1994/1995	14.3	57.9	80.1	27.8	18.4	22.7
2009	9.2*	54.6	85.6*	36.2*	16.6	21.8
Women						
Total 25 or older						
1994/1995	23.2	24.5	51.3	52.3	17.5	15.3
2009	14.5*	26.8*	64.8*	58.7*	13.7*	14.5*
25 to 44						
1994/1995	28.6	22.7	44.2	48.6	17.1	15.1
2009	15.7*	20.4*	56.5*	63.9*	12.2*	11.7*
45 to 64						
1994/1995	22.4	25.9	53.6	51.7	19.0	16.5
2009	17.2*	31.4*	64.6*	51.4	15.2*	15.9
65 or older						
1994/1995	10.5	26.8	71.8	62.7	15.0	13.9
2009	7.1*	30.2	80.9*	62.7	12.8*	15.4*

* significantly different from 1994/1995
Source: 1994/1995 National Population Health Survey (cross-sectional file), 2009 Canadian Community Health Survey